WHITE PAPER

USDA Forest Service | Pacific Northwest Region | Umatilla National Forest

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Seral Status for Tree Species of the Blue and Ochoco Mountains[1]

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INTRODUCTION

This white paper describes and discusses seral status for tree species of the Blue and Ochoco Mountains in northeastern Oregon, southeastern Washington, and west-central Idaho. Information about tree species seral status is provided in two figures, both of which show seral status by tree species and plant association. One figure organizes plant associations by potential vegetation group, the other by plant series.

What is seral status ('seral stages')? Seral status refers to the role or function (character) of vegetation in a plant community. Is the vegetation relatively 'stable' (persistent) and regenerating itself, or is it 'unstable' and experiencing rapid change as other types of vegetation replace it? Seral status (stages) provides a useful communication tool for characterizing the relative 'stability' or 'instability' of plant communities.

Plant succession is the replacement of one plant community with another. Succession can be slow after severe site changes caused by volcanoes, glaciers, landslides, and similar events. But most commonly, succession occurs relatively quickly in response to disturbances such as wildfire, flooding, insect outbreaks, or disease epidemics. A complete cycle of changes for a disturbed area, from initial (open) conditions to a mature community, is called a sere. Intermediate steps in a plant succession are seral stages.

[1] White papers are internal reports; they receive only limited review. Viewpoints expressed in this paper are those of the author – they may not represent positions of the USDA Forest Service.

Four categories or stages of seral status are recognized (Hall et al. 1995):

- **Early seral**: a plant community has clear dominance of early-seral ('pioneer') species; PNC species are absent, or present only in low amounts.
- **Mid seral**: PNC species are colonizing the site and slowly increasing; they are approaching equal proportions with early-seral species.
- **Late seral**: PNC species are clearly dominant, but some early- and mid-seral species still exist (especially when long-lived such as ponderosa pine or western larch).
- **Potential Natural Community (PNC)**: the potential natural community under existing environmental and macroclimatic conditions; early- or mid-seral species are scarce or absent. The ecological literature often refers to this as the 'climax' stage.

Of the four stages described above, PNC (Potential Natural Community) is often the most difficult one to grasp, particularly for the Interior Pacific Northwest where disturbance processes are ubiquitous and examples of 'climax' (PNC) forest stands, undisturbed for many centuries, are rarely found.

In ecological literature describing plant succession and development, PNC is often characterized as a 'climax' stage. In Whittaker's seminal work about climax theory (Whittaker 1953), he defines the climax stage as a plant community where (1) slow changes in plant composition occur, rather than rapid, strongly directional changes (note that Whittaker doesn't really account for changes in stand structure; change is assessed primarily in the context of plant composition); (2) reproduction of existing plant species (late-seral/PNC species) is occurring regularly; (3) 'regularity' (homogeneity) occurs within stands; and (4) similarity occurs between stands growing on similar sites.

Whittaker's (1953) climax theory presumes that similarity between 'climax' stands *on similar sites* is a prerequisite (item #4 above). Subsequent studies involving old-growth forest stands (ostensibly climax forests) in the northern Rockies raise doubts about his assumption. McCune and Allen (1985) examined how much of the floristic composition of an area is due to abiotic factors (e.g., site similarity) versus historical factors (e.g., stand development and succession).

The McCune and Allen (1985) study used mature (old-growth) forests established in a narrow range of similar environments. Results suggest that chance (stochasticity in ecological terms) plays an important role in vegetation development, and that succession (development of a sere through time) can occur at varying rates and have multiple endpoints. In other words, forest stands growing on similar sites don't always develop a similar composition at 'climax,' as Whittaker (1953) presumed they would.

[More information about this concept generally, and about McCune and Allen's (1985) study specifically, is provided in silviculture white paper F14-SO-WP-SILV-7: *Active Management of Moist Forests in the Blue Mountains: Silvicultural Considerations*

(Powell 2014). In particular, see: *Box 4. Will Similar Old Growth Develop on Similar Sites?* (page 49 in Powell 2014) for details about McCune and Allen's (1985) study.]

LAND MANAGEMENT AND SERAL STATUS

Differences in seral status have an important bearing on how managers deal with lands and resources entrusted to their care. The influence of seral status on silviculture and forest management is a primary reason for preparing this white paper. Disturbance affects vegetation, resulting not only in differing responses between tree species, but also causing varying responses between life-form layers. We typically see different types and rates of response between life forms: trees respond differently than shrubs, and shrubs respond differently than herbs. This white paper discusses trees only.

Understanding seral relationships of tree species is an important skill for silviculturists, especially when dealing with mixed-species stands because seldom does every species in a mixture have the same seral status. Why is this knowledge important? I will explore a few responses to this question by providing examples specific to the Blue and Ochoco Mountains province.

The Blue and Ochoco Mountains are a transverse mountain range extending in a southwest to northeast orientation from central Oregon near Prineville (Ochoco Mountains) to the northern Blue Mountains and Seven Devils Mountains in southeastern Washington and west-central Idaho. This mountain mass is transverse because it extends from the Cascade Mountains on the west, to the main portion of the middle Rocky Mountains on the east. This collection of mountain ranges, consisting of the Blue, Ochoco, Wallowa, Seven Devils, Greenhorn, and other smaller ranges, is known collectively as the Blue Mountains section (McNab and Avers 1994, Powell et al. 2007).

Both the Cascade and Rocky Mountain ranges are considerably higher in elevation than the Blue/Ochoco Mountains. Since the Blue Mountains section is relatively low in elevation (except for portions of the Wallowa and Seven Devils mountains in the far eastern portion, where the Blues transition into the Rockies), they contain few examples of subalpine or alpine environments.

Much of the Blue Mountains section consists of valley grasslands, where most human settlements are located, along with dry or mesic forest environments occurring in the foothills or montane vegetation zones. For this reason, perhaps the best tree species to use as a seral-status example for the Blue Mountains section is ponderosa pine.

Why use ponderosa pine? In the context of the Blues, ponderosa pine has relatively wide ecological amplitude – it occupies a diversity of niches extending from very dry (xeric) habitats in the upper foothills zone, to mesic (moderate moisture) or moist settings in the upper montane or lower subalpine zones. For high-elevation mountain ranges containing abundant subalpine or alpine environment, ponderosa pine is not a good example species because it lacks sufficient amplitude to prosper in high-elevation habitats.

"Ecological amplitude controls how a plant species interacts with physical site factors such as altitude (elevation), aspect, geology, and soil type" (Powell et al. 2007, p. 5). Ponderosa pine is one of the most widely distributed pines in western North America (Burns and Honkala 1990). Its amplitude allows it to have differing seral status in the Blues, depending on which type of habitat (e.g., niche; ecological setting) it occupies.

On very dry habitats, ponderosa pine functions as a dominant, persistent species (a late-seral or 'climax' species) where it may be the only tall-stature tree present (although a woodlands species such as western juniper may also occur on these dry sites). As elevations increase and dry foothills sites give way to mesic montane environments, ponderosa pine is joined by other species such as Douglas-fir and grand fir. In these forest settings, ponderosa pine functions as an early-seral or mid-seral species, depending on how warm and dry the environments are.

But why is ponderosa pine suitable for illustrating seral status variability of tree species for the Blues? Consider an example (taken from Powell et al. 2007) for a mixed composition dominated by ponderosa pine and grand fir, which I believe is more common in the Blues than pure stands of either species.

"The presence of ponderosa pine in stands trending toward domination by grand fir may indicate only that one or more mature ponderosa pines happened to be within seed dissemination distance when the last wildfire or other disturbance event occurred. How might a land manager come to this conclusion?

Shade-intolerant tree species such as ponderosa pine can colonize sites that are moister than they can hold onto when facing competition from shade-tolerant species such as grand fir; ponderosa pine and grand fir occurring together on the grand fir/twinflower plant association is an example of this situation for the Blue Mountains section (Johnson and Clausnitzer 1992).

This species occurrence pattern suggests that varying proportions of ponderosa pine and grand fir may not indicate changes in temperature or moisture relationships (ponderosa pine indicating warm and dry microsites; grand fir indicating cool and moist microsites), but may instead represent an expected progression in a post-disturbance sere where early-seral ponderosa pine is gradually being replaced by late-seral grand fir (Daubenmire 1966).

This example illustrates that the proportion of ponderosa pine in a mixed-conifer stand may have limited indicator value with respect to a site's temperature and moisture status, [or whether ponderosa pine should possibly be considered as a climax species for the site,] but it might be useful as an indicator of how much time has passed since the last wildfire or other disturbance event with sufficient intensity to initiate a cohort of early-seral tree species (Daubenmire 1966)."

How else might foresters use their knowledge about seral status when managing natural resources? Often, seral status insights are important when using a concept called management implications. A *management implication* is the response of an ecosystem to a management practice or a disturbance agent (Powell 2000). Generally, seral status is used in conjunction with other knowledge and skills when developing and using management implications.

Seral status insights allow a manager to predict which shade-tolerant tree species will get established beneath an existing stand of shade-intolerant species. Knowledge about the potential vegetation status of a site, however, provides additional insights because potential vegetation (PV) has an important influence on ecosystem processes. PV is an ecological engine powering vegetation change – it controls the speed at which shade-tolerant species get established beneath shade-intolerant trees.

So, a land manager has a mixed stand of lodgepole pine and western larch, but previous experience suggests it will likely be replaced by other tree species at some point. The manager wonders – which species might overtake the pine and larch, and how soon might this change occur? Insights about tree species seral status, along with knowledge about a site's PV status (which plant association is present, and how 'productive' is it in terms of tree growth?), allows a manager to reach a reasonably well-informed conclusion about replacement species (grand fir and perhaps a few subalpine fir will replace the pine and larch), and when they might predominate (likely in 40 years or less).

Here are two other examples of how managers could use tree species seral status information to inform their decisions about how to implement common management practices (many additional examples could have been provided):

- **Developing reforestation prescriptions.** Historically, foresters often planted the same species that had been harvested, perhaps not realizing that the late-seral trees they just removed are poorly adapted to post-harvest conditions. And in other instances, they planted a commercially valuable species where it wasn't well suited, such as ponderosa pine on cold or wet sites.

  As early as 1683, foresters in Germany recognized that every tree species would not be acceptable on every forest site (Boerker 1916). Knowing the indicator status of tree species occurring in a plant association can greatly improve reforestation success, with early-seral species best adapted to open conditions and mid-seral species suitable for partially shaded environments (Zon 1915).

- **Assessing forest (tree) density.** Manipulation of stocking levels has important impacts on stand development and the appearance of future forest landscapes. Suggested stocking levels were recently developed for every plant association occurring in the Blue-Ochoco and Wallowa-Snake physiographic provinces (Cochran et al. 1994, Powell 1999).

  When developing density-management prescriptions, foresters need to consider tree species seral status because as a general rule, early-seral tree species require more growing space than late-seral trees. This consideration is especially important for plant associations with the capability to support a diversity of tree species.

  For example, consider the grand fir/twinflower plant association (ABGR/LIBO2) – it has the capability to support all 7 of the primary Blue Mountain conifers, but the 'stockability' values vary between species. At a quadratic mean diameter of 10 inches, ABGR/LIBO2 sites could support a low of 189 square feet of basal area, per acre, for a lodgepole pine stand at maximum density, ranging up to a high of 352 square feet of basal area, per acre, for a grand fir stand at maximum density. So, for the same reference level (maximum density in this example), a single plant association could support tree stands ranging from 189 to 352 square feet of basal area per acre (other basal-area values are: 249 for ponderosa pine, 253 for western larch, 254 for subalpine fir, 259 for Douglas-fir, and 272 for Engelmann spruce).

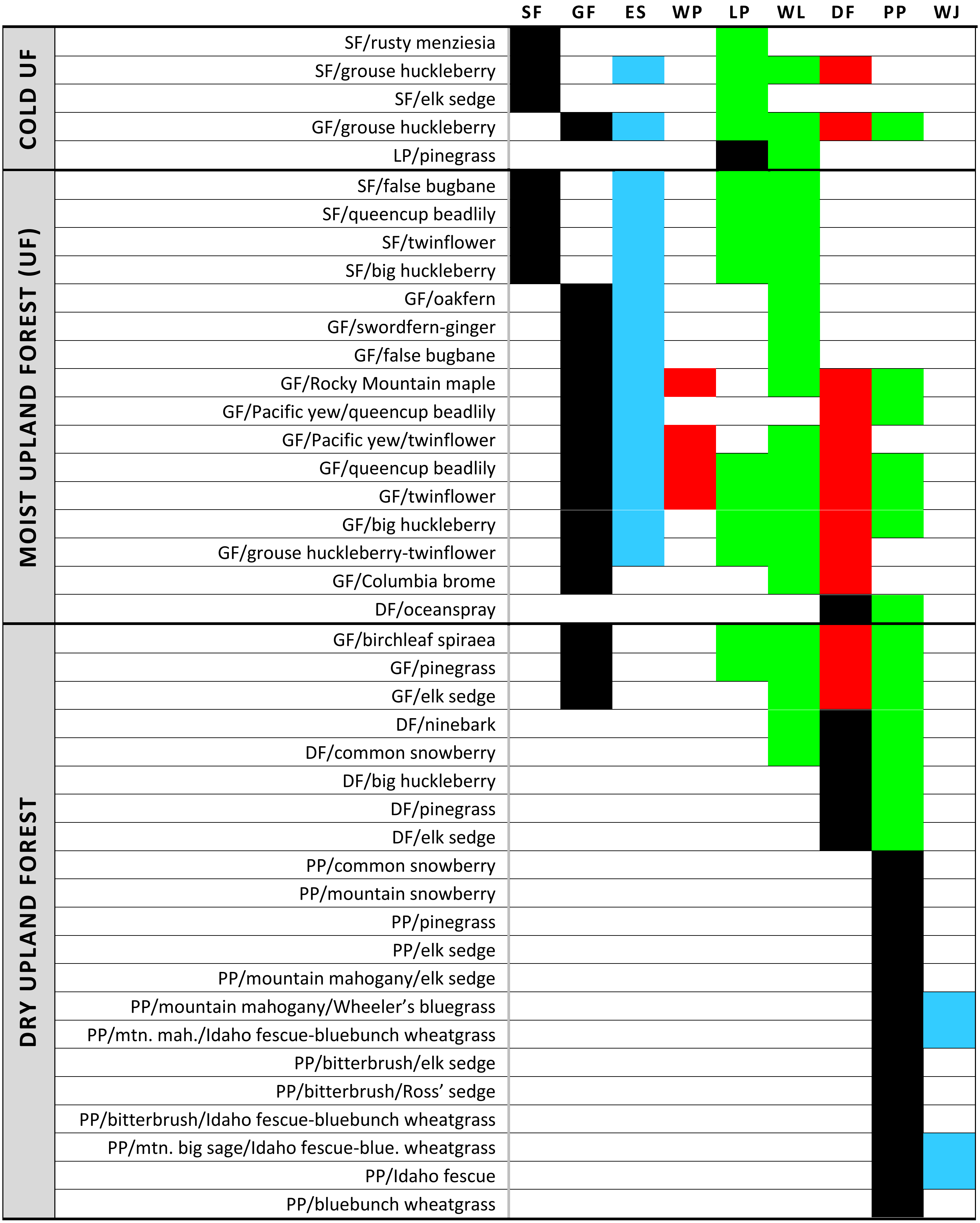

Figure 1 – Tree species seral status for upland forest plant associations, organized by potential vegetation group.

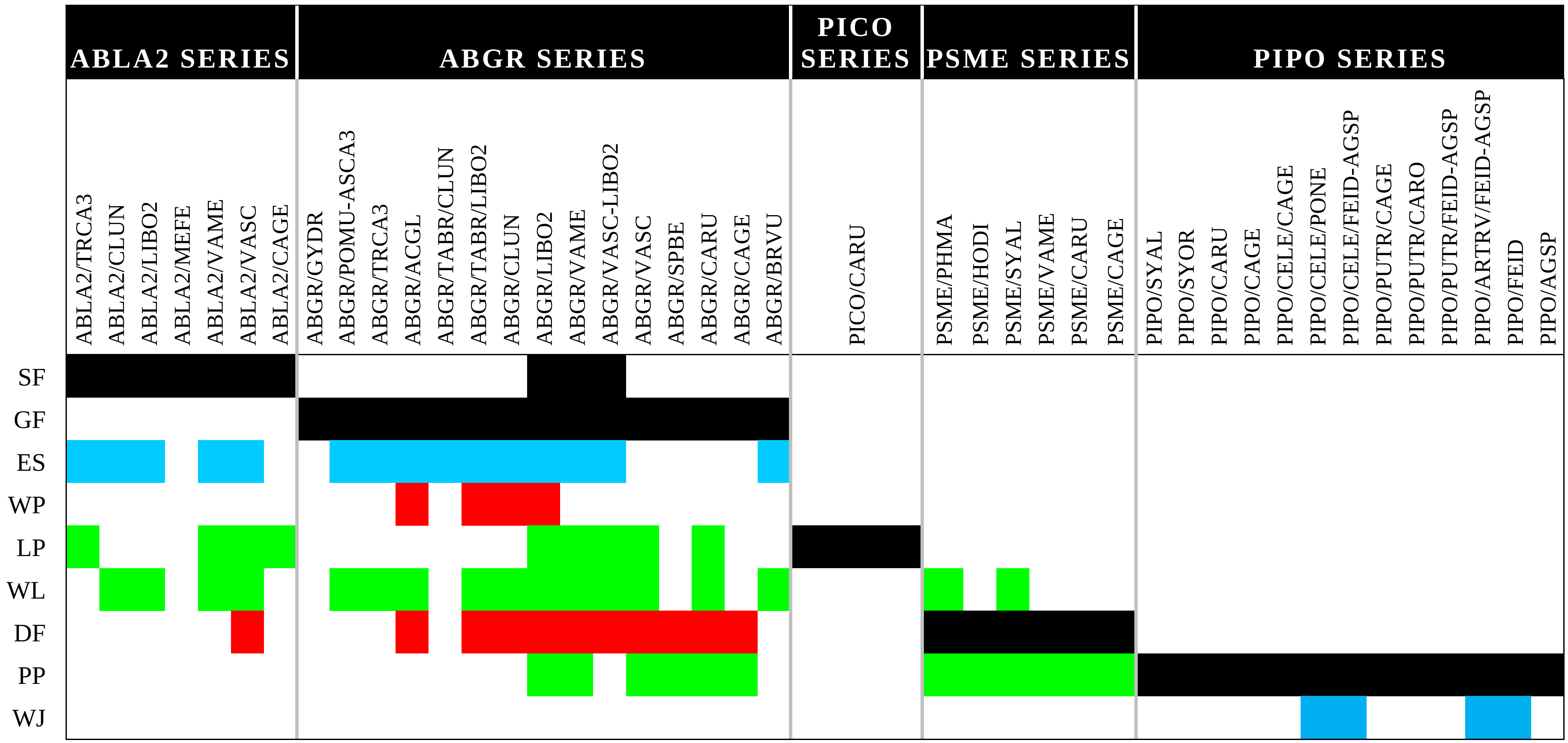

Figure 2 – Tree species seral status for upland forest plant associations, organized by plant series.

BACKGROUND INFORMATION FOR FIGURES 1-2

Figures 1 and 2 both include plant associations – figure 1 refers to associations by using 2-digit tree species codes (see table at end of this section) and common plant names. Figure 2 refers to associations by using their alphanumeric acronyms, which "are derived from scientific plant names: the first two letters of the genus name are combined with the first two letters of the species name and capitalized (e.g., ABGR for *Abies grandis*). If more than one species has the same code, then a number is added to differentiate between them (e.g., PIMO3 for *Pinus monticola*)" (Powell et al. 2007, p. 4).

Figure 1 arranges upland-forest plant associations of the Blue and Ochoco Mountains by Potential Vegetation Group (PVG) (Powell et al. 2007), and plant associations are ordered from moist to dry (top to bottom) within a PVG. Three upland-forest PVGs are included in figure 1: Cold, Moist, and Dry.

"Potential vegetation group is an aggregation of plant association groups (PAGs) with similar environmental regimes and dominant plant species. Each aggregation (PVG) typically includes PAGs representing a predominant temperature or moisture influence (Powell 2000). Potential vegetation group is the middle level of the midscale portion of the Blue Mountains potential vegetation hierarchy" (Powell et al. 2007, p. 40).

Figure 2 arranges upland-forest plant associations of the Blue and Ochoco Mountains by plant series, and plant associations are ordered from moist to dry (left to right) within a series. Five upland-forest series are included in figure 2: subalpine fir (ABLA2), grand fir (ABGR), lodgepole pine (PICO), Douglas-fir (PSME), and ponderosa pine (PIPO).

Plant "series is a taxonomic unit in a potential vegetation classification system. A series represents major environmental differences as reflected by physiognomically dominant plant species at climax. A forest series is named for the projected climax tree species – the grand fir series includes every plant association where grand fir is presumed to be the dominant tree species at climax (Pfister and Arno 1980). Series is the highest level of the fine-scale portion of the Blue Mountains potential vegetation hierarchy" (Powell et al. 2007, p. 42).

Plant associations shown in figures 1 and 2 are based on a publication entitled ***Plant Associations of the Blue and Ochoco Mountains*** (Johnson and Clausnitzer 1992). Which of the tree species occur with each plant association? Tree species shown as being associated with a particular plant association are based on the constancy tables (appendix C) and the Forest Productivity Table (appendix D) from Johnson and Clausnitzer (1992), which means they were consistently encountered during field sampling to develop the plant-association classification.

Potential vegetation groups are based on a publication entitled ***Potential Vegetation Hierarchy for the Blue Mountains Section of Northeastern Oregon, Southeastern Washington, and West-Central Idaho*** (Powell et al. 2007).

Seral status of tree species, by plant association, was interpreted by the author of this white paper, and informed by these sources: Clausnitzer (1993), Hall (1973), Powell (2000), and Steele et al. (1981). Seral status concepts are explained in more detail by Hall et al. (1995).

TREE SPECIES CODES

SF: subalpine fir
GF: grand fir
ES: Engelmann spruce
WP: western white pine
LP: lodgepole pine
WL: western larch
DF: interior Douglas-fir
PP: ponderosa pine
WJ: western juniper

SERAL STATUS COLORS

Black: climax (dominates the potential natural community)
Blue: late-seral status
Red: mid-seral status
Green: early-seral status

COMMON NAMES FOR PLANT ASSOCIATION ACRONYMS

Acronym	Common name
ABGR/ACGL	Grand fir/Rocky Mountain maple
ABGR/BRVU	Grand fir/Columbia brome
ABGR/CAGE	Grand fir/elk sedge
ABGR/CARU	Grand fir/pinegrass
ABGR/CLUN	Grand fir/queencup beadlily
ABGR/GYDR	Grand fir/oakfern
ABGR/LIBO2	Grand fir/twinflower
ABGR/POMU-ASCA3	Grand fir/swordfern-ginger
ABGR/SPBE	Grand fir/birchleaf spiraea
ABGR/TABR/CLUN	Grand fir/Pacific yew/queencup beadlily
ABGR/TABR/LIBO2	Grand fir/Pacific yew/twinflower
ABGR/TRCA3	Grand fir/false bugbane
ABGR/VAME	Grand fir/big huckleberry
ABGR/VASC	Grand fir/grouse huckleberry

Acronym	Common name
ABGR/VASC-LIBO2	Grand fir/grouse huckleberry-twinflower
ABLA2/CAGE	Subalpine fir/elk sedge
ABLA2/CLUN	Subalpine fir/queencup beadlily
ABLA2/LIBO2	Subalpine fir/twinflower
ABLA2/MEFE	Subalpine fir/rusty menziesia
ABLA2/TRCA3	Subalpine fir/false bugbane
ABLA2/VAME	Subalpine fir/big huckleberry
ABLA2/VASC	Subalpine fir/grouse huckleberry
PICO/CARU	Lodgepole pine/pinegrass
PIPO/AGSP	Ponderosa pine/bluebunch wheatgrass
PIPO/ARTRV/FEID-AGSP	PP/mountain big sage/Idaho fescue-blue. wheatgrass
PIPO/CAGE	Ponderosa pine/elk sedge
PIPO/CARU	Ponderosa pine/pinegrass
PIPO/CELE/CAGE	Ponderosa pine/mountain mahogany/elk sedge
PIPO/CELE/FEID-AGSP	PP/mountain mahogany/Idaho fescue-blue. wheatgrass
PIPO/CELE/PONE	Ponderosa pine/mountain mahogany/Wheeler's bluegrass
PIPO/FEID	Ponderosa pine/Idaho fescue
PIPO/PUTR/CAGE	Ponderosa pine/bitterbrush/elk sedge
PIPO/PUTR/CARO	Ponderosa pine/bitterbrush/Ross' sedge
PIPO/PUTR/FEID-AGSP	PP/bitterbrush/Idaho fescue-bluebunch wheatgrass
PIPO/SYAL	Ponderosa pine/common snowberry
PIPO/SYOR	Ponderosa pine/mountain snowberry
PSME/CAGE	Douglas-fir/elk sedge
PSME/CARU	Douglas-fir/pinegrass
PSME/HODI	Douglas-fir/oceanspray
PSME/PHMA	Douglas-fir/ninebark
PSME/SYAL	Douglas-fir/common snowberry
PSME/VAME	Douglas-fir/big huckleberry

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APPENDIX: SILVICULTURE WHITE PAPERS

White papers are internal reports, and they are produced with a consistent formatting and numbering scheme – all papers dealing with Silviculture, for example, are placed in a silviculture series (Silv) and numbered sequentially. Generally, white papers receive only limited review and, in some instances pertaining to highly technical or narrowly focused topics, the papers may receive no technical peer review at all. For papers that receive no review, the viewpoints and perspectives expressed in the paper are those of the author only, and do not necessarily represent agency positions of the Umatilla National Forest or the USDA Forest Service.

Large or important papers, such as two papers discussing active management considerations for dry and moist forests (white papers Silv-4 and Silv-7, respectively), receive extensive review comparable to what would occur for a research station general technical report (but they don't receive blind peer review, a process often used for journal articles).

White papers are designed to address a variety of objectives:

(1) They guide how a methodology, model, or procedure is used by practitioners on the Umatilla National Forest (to ensure consistency from one unit, or project, to another).
(2) Papers are often prepared to address ongoing and recurring needs; some papers have existed for more than 20 years and still receive high use, indicating that the need (or issue) has long standing – an example is white paper #1 describing the Forest's big-tree program, which has operated continuously for 25 years.
(3) Papers are sometimes prepared to address emerging or controversial issues, such as management of moist forests, elk thermal cover, or aspen forest in the Blue Mountains. These papers help establish a foundation of relevant literature, concepts, and principles that continuously evolve as an issue matures, and hence they may experience many iterations through time. [But also note that some papers have not changed since their initial development, in which case they reflect historical concepts or procedures.]
(4) Papers synthesize science viewed as particularly relevant to geographical and management contexts for the Umatilla National Forest. This is considered to be the Forest's self-selected 'best available science' (BAS), realizing that non-agency commenters would generally have a different conception of what constitutes BAS – like beauty, BAS is in the eye of the beholder.
(5) The objective of some papers is to locate and summarize the science germane to a particular topic or issue, including obscure sources such as master's theses or Ph.D.

dissertations. In other instances, a paper may be designed to wade through an overwhelming amount of published science (dry-forest management), and then synthesize sources viewed as being most relevant to a local context.

(6) White papers function as a citable literature source for methodologies, models, and procedures used during environmental analysis – by citing a white paper, specialist reports can include less verbiage describing analytical databases, techniques, and so forth, some of which change little (if at all) from one planning effort to another.

(7) White papers are often used to describe how a map, database, or other product was developed. In this situation, the white paper functions as a 'user's guide' for the new product. Examples include papers dealing with historical products: (a) historical fire extents for the Tucannon watershed (WP Silv-21); (b) an 1880s map developed from General Land Office survey notes (WP Silv-41); and (c) a description of historical mapping sources (24 separate items) available from the Forest's history website (WP Silv-23).

The following papers are available from the Forest's website: Silviculture White Papers

Paper #	Title
1	Big tree program
2	Description of composite vegetation database
3	Range of variation recommendations for dry, moist, and cold forests
4	Active management of dry forests in the Blue Mountains: silvicultural considerations
5	Site productivity estimates for upland forest plant associations of the Blue and Ochoco Mountains
6	Fire regimes of the Blue Mountains
7	Active management of moist forests in the Blue Mountains: silvicultural considerations
8	Keys for identifying forest series and plant associations of the Blue and Ochoco Mountains
9	Is elk thermal cover ecologically sustainable?
10	A stage is a stage is a stage…or is it? Successional stages, structural stages, seral stages
11	Blue Mountains vegetation chronology
12	Calculated values of basal area and board-foot timber volume for existing (known) values of canopy cover
13	Created opening, minimum stocking, and reforestation standards from the Umatilla National Forest Land and Resource Management Plan
14	Description of EVG-PI database
15	Determining green-tree replacements for snags: a process paper

Paper #	Title
16	Douglas-fir tussock moth: a briefing paper
17	Fact sheet: Forest Service trust funds
18	Fire regime condition class queries
19	Forest health notes for an Interior Columbia Basin Ecosystem Management Project field trip on July 30, 1998 (handout)
20	Height-diameter equations for tree species of the Blue and Wallowa Mountains
21	Historical fires in the headwaters portion of the Tucannon River watershed
22	Range of variation recommendations for insect and disease susceptibility
23	Historical vegetation mapping
24	How to measure a big tree
25	Important insects and diseases of the Blue Mountains
26	Is this stand overstocked? An environmental education activity
27	Mechanized timber harvest: some ecosystem management considerations
28	Common plants of the south-central Blue Mountains (Malheur National Forest)
29	Potential natural vegetation of the Umatilla National Forest
30	Potential vegetation mapping chronology
31	Probability of tree mortality as related to fire-caused crown scorch
32	Review of the "Integrated scientific assessment for ecosystem management in the interior Columbia basin, and portions of the Klamath and Great basins" – forest vegetation
33	Silviculture facts
34	Silvicultural activities: description and terminology
35	Site potential tree height estimates for the Pomeroy and Walla Walla ranger districts
36	Tree density protocol for mid-scale assessments
37	Tree density thresholds as related to crown-fire susceptibility
38	Umatilla National Forest Land and Resource Management Plan: forestry direction
39	Updates of maximum stand density index and site index for the Blue Mountains variant of the Forest Vegetation Simulator
40	Competing vegetation analysis for the southern portion of the Tower Fire area
41	Using General Land Office survey notes to characterize historical vegetation conditions for the Umatilla National Forest
42	Life history traits for common conifer trees of the Blue Mountains
43	Timber volume reductions associated with green-tree snag replacements

Paper #	Title
44	Density management field exercise
45	Climate change and carbon sequestration: vegetation management considerations
46	The Knutson-Vandenberg (K-V) program
47	Active management of quaking aspen plant communities in the northern Blue Mountains: regeneration ecology and silvicultural considerations
48	The Tower Fire…then and now. Using camera points to monitor postfire recovery
49	How to prepare a silvicultural prescription for uneven-aged management
50	Stand density conditions for the Umatilla National Forest: a range of variation analysis
51	Restoration opportunities for upland forest environments of the Umatilla National Forest
52	New perspectives in riparian management: Why might we want to consider active management for certain portions of riparian habitat conservation areas?
53	Eastside Screens chronology
54	Using mathematics in forestry: an environmental education activity
55	Silviculture certification: Tips, tools, and trip-ups
56	Vegetation polygon mapping and classification standards: Malheur, Umatilla, and Wallowa-Whitman national forests
57	The state of vegetation databases on the Malheur, Umatilla, and Wallowa-Whitman national forests
58	Seral status for tree species of the Blue and Ochoco Mountains

REVISION HISTORY

May 2006: the information in this white paper was originally prepared in May 2006 as handout material for a Fire Regime Condition Class workshop. It received several minor revisions after that when being used for other trainings or purposes.

May 2017: minor formatting and text edits were made throughout the document, and a new appendix was added describing the silviculture white papers system. A color, first-page header and other white-paper formatting was also completed at this time.